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Indirect Exposure to the September 11 Terrorist Attacks: Does Symptom Structure Resemble PTSD?

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The authors conducted confirmatory factor analyses of reports of posttraumatic stress reactions using a national probability sample of individuals indirectly exposed to the terrorist attacks of September 11, 2001 (n = 675). Reactions at three time points in the year after the attacks were best accounted for by a lower-order, 4-factor solution (Reexperiencing, Strategic Avoidance, Emotional Numbing, and Hyperarousal Symptoms). Indirect exposure to a traumatic event appears to induce a response with a similar symptom structure as responses to direct exposure.

For some individuals, the terrorist events of September 11, 2001 (9/11) had an enduring impact on well-being and functioning that cannot be fully explained by direct exposure or close proximity (e.g., Schlenger et al., 2002; Silver, Holman, McIntosh, Poulin, & Gil-Rivas, 2002; Silver et al., 2005). However, how to conceptualize the lingering mental health problems that may stem from indirect exposure to a shared national tragedy remains unclear. The psychological response to the events of 9/11 poses a challenge to the extant ways of thinking about traumatic events and response to severe stress. To what degree does the emotional residue of indirect exposure to 9/11, such as real-time viewing of airplanes hitting the World Trade Center (WTC), produce reactions that mimic the symptoms and time course seen in posttraumatic stress disorder (PTSD; American Psychiatric Association, 2000)? Are untoward reactions to indirect exposure the tail end of a continuum of stress reactions or general distress?

There is precedent to consider indirect exposure to trauma as a sufficient condition for the development of PTSD; for example, the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (*DSM-IV-TR*; APA, 2000, p. 463) includes indirect exposure via learning about harm to intimates. However, should indirect exposure to strangers' trauma be included? Recent research on indirect trauma exposure in relief workers from Ground Zero (WTC) has suggested that nontrivial PTSD symptoms can result from indirect exposure in the absence of a personal connection to the victim (e.g., Zimering, Gulliver, Knight, Munroe, & Keane, 2006). In contrast, vicarious or secondary traumatization, another example of indirect exposure to others'

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severe suffering, can be explained by a variety of factors, including therapists' trauma history and coping styles (Sabin-Farrell & Turpin, 2003).

To date, clinicians and researchers have assumed that real-time indirect exposure to the 9/11 events is a trauma and that PTSD is the relevant associated mental health outcome, especially for those particularly vulnerable (e.g., with history of mental health difficulties, cf. Silver et al., 2002). Although hours of television watching was not associated with PTSD symptoms in adults seeking mental-health services following the Oklahoma City bombing (Tucker, Pfefferbaum, Nixon, & Dickson, 2000), television exposure was associated with greater PTSD symptomatology after 9/11 (e.g., Schlenger et al., 2002; Silver et al., 2002). As would be expected, there are a number of factors that potentiate stress symptoms (including PTSD) stemming from indirect exposure to 9/11, including preexisting serious mental health problems (Pollack et al., 2006), a perievent panic attack (Ahern, Galea, Resnick, & Vlahov, 2004), coping styles (Silver et al., 2002), and prior trauma (Ahern et al., 2004). Research is needed to clarify the optimal way to conceptualize the lasting psychological impact of indirect exposure to terror.

One way to approach this problem is to consider whether stress symptoms following indirect exposure to 9/11 cohere in a manner expected of PTSD. Thus, does indirect exposure to terror lead to reliable subclustering of PTSD symptoms? More than 10 published confirmatory factor analysis (CFA) examinations of PTSD symptoms in individuals *directly* exposed to trauma have found between one and five factors (see Asmundson, Stapleton, & Taylor, 2004; King, King, Orazem, & Palmieri, 2006). The existing evidence fails to confirm the 3-factor *DSM-IV-TR* model of PTSD and supports separating avoidance and numbing (Criteria C) into two clusters. Commonly, a 4-factor solution has emerged as best fitting, consisting of Reexperiencing, Strategic Avoidance, Numbing, and Hyperarousal (King et al., 2006), although a 4-factor model with "dysphoria," rather than "numbing," has also been obtained (Simms, Watson, & Doebbelling, 2002).

To date, only one study has examined the factor structure of posttraumatic stress (PTS) in response to indirect trauma exposure. Baschnagel, O'Connor, Colder, and Hawk (2005) used CFA to examine seven models of PTS using undergraduate students from western New York who were assessed 1 and 3 months after 9/11. One-, two-, and three-factor models did not fit the data. Instead, a model originally proposed by Simms et al. (2002) that included a Reexperiencing factor, a Hyperarousal factor with two items (hypervigilance, exaggerated startle), an Avoidance factor including two criteria that refer directly to strategic avoidance, and a fourth factor, labeled Dysphoria, consisting of the remaining Cluster C and D items, best fit the data. We explored whether a reliable subclustering of PTSD symptoms could be demonstrated longitudinally in an adult sample that was indirectly exposed to terror. We used data from a study that followed a nationally representative sample several points in time after 9/11. We disaggregated reports of PTS reactions into their constituent clusters of symptoms or problems and evaluated a series of competing models using confirmatory factor analyses (CFAs) to examine which model best fit the data.

METHOD

Participants

We used data from a longitudinal study conducted by Silver and colleagues (Silver et al., 2002, 2006). Shortly after 9/11, a national probability sample of 3496 adults was invited to complete a Web-based survey on their reactions to the attacks (Wave 1); 2729 completed it (a 78% participation rate), and the resulting sample closely matched Current Population Survey (CPS) benchmarks from the U.S. Census Bureau (see Silver et al., 2002). Over 75% of respondents completed the survey within 14 days postattacks; the remainder completed it within the following week. A randomly drawn subsample of 933 participants who lived outside the New York City metropolitan community (933 of 1069; 87% participation rate) completed a second survey approximately 2 months following 9/11 (Wave 2). Individuals who completed Waves 1 and 2 were invited to participate at Wave 3 approximately 6 months after 9/11; 787 participants did so (92% participation rate of available and eligible respondents; see Silver et al., 2002). Approximately one-year post-9/11, another survey was fielded to the Wave 1 sample; 2033 individuals from the original sample completed the survey again (Wave 4; 75% participation rate). At Wave 4, this sample continued to be representative of the adult U.S. population (see Silver et al., 2006).

Complete data were available for 685 participants at Waves 1–4. Because the focus of this report is on PTS factor structure and Wave 1 was collected prior to the accepted onset of PTSD (i.e., 1 month postevent; APA, 2000), responses from participants with data on measures of PTS symptomatology at Waves 2–4 were analyzed. Five cases were deleted because of an excess of missing data from the PTSD measure at one or more time points, and five were deleted after reporting direct exposure to the attacks.

We used Stata statistical software (StataCorp, 2003), which allows for the inclusion of sample design weights, to conduct a series of χ^2 tests and one-way ANOVAs examining demographic variables for the 675 participants compared to all other Wave 1 participants ($n = 2054$). These groups did not differ on gender, race, ethnicity, marital status, education, or household income. Participants with complete data ($M = 47.3$ years, $SD = 16.5$) were somewhat older than those without it ($M = 44.4$ years, $SD = 16.7$), $F(1, 2727) = 16.04$, $p < .01$. In addition, Table 1 demonstrates that demographics from the current sample compare favorably to the September 2001 CPS benchmarks (U.S. Census Bureau, 2001; e.g., few statistically significant differences emerged and differences were very small). Thus, the current sample did not differ substantially from the U.S. adult population.

Table 1. Demographic Data

Characteristic	Unweighted *n*	Unweighted %	Weighted[a] *n*	Weighted[a] %	U.S. Census[a] %
Sex					
Male	340	50.4	352	50.7	48.0*
Female	335	49.6	342	49.3	52.0*
Marital status					
Married	409	61.9	420	61.1	57.1*
Single	120	18.2	133	19.7	24.1*
Separated/divorced/widowed	132	20.0	125	18.4	18.8
Race					
White	552	86.1	542	82.3	83.2
Black/African American	55	8.6	75	11.4	11.9
Native American	8	1.3	11	1.6	0.9
Asian/Pacific Islander	9	1.4	10	1.5	4.0
Other	17	2.7	21	3.2	NA
Ethnicity					
Non-Hispanic	593	88.5	594	86.2	89.2*
Hispanic	52	7.8	71	10.3	10.8
Education					
Less than high school	55	8.2	101	14.7	15.8
High school diploma or equivalent	245	36.6	229	33.2	33.0
Some college	169	25.3	166	24.0	19.3*
Associate degree	33	4.9	32	4.7	7.8*
Bachelor degree or beyond	167	25.0	161	23.4	24.1
Household Income					
<10,000	18	3.2	16	2.8	7.4*
10,000–24,999	114	20.1	136	23.5	18.4*
25,000–49,999	235	41.4	241	41.8	28.5*
50,000–74,999	120	21.2	114	19.7	20.0
≥75,000	80	14.1	70	12.1	25.7*

Notes: From *Current Population Survey* by U.S. Bureau of the Census, September 2001, Washington, DC: Author. NA = Not available.
[a] Weights adjust estimates for sampling design and poststratification to the Census characteristics.
*Indicates significant difference ($p > .05$) between weighted sample and Census.

Measures

Posttraumatic stress reactions at Waves 2 and 3 were assessed with the Impact of Events Scale-Revised (IES-R; Weiss & Marmar, 1997). This 22-item scale measured the extent to which participants were bothered by PTS symptoms resulting from the 9/11 attacks on a 5-point Likert-type scale (0 = *not at all* to 4 = *extremely*). The IES-R is a revised version of the widely used original IES (Horowitz, Wilner, & Alvarez, 1979), updated to include items measuring persistent hyperarousal. Although multiple studies have reported solid psychometric properties for the IES-R (e.g., Creamer, Bell, & Failla, 2003; Weiss & Marmar, 1997), its construct validity remains to be fully explored because no prior study has evaluated the 4-factor solutions found to best capture other PTSD measures (see above). The IES-R features three subscales: intrusion, avoidance, and hyperarousal. For these analyses, two emotional numbing items were extracted from the avoidance items, and one avoidance item that did not tap strategic avoidance was excluded. The resulting scale included 21 items: 2 emotional numbing, 7 reexperiencing, 5 strategic avoidance, and 7 hyperarousal.

To enable direct comparison to methodology employed in other national investigations of the 9/11 attacks (e.g., Schlenger et al., 2002), the PTSD Checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993) was substituted at Wave 4. Both the IES-R and PCL utilize overlapping items and constructs. The PCL is a 17-item index of the extent to which participants were bothered by PTS symptoms resulting from the 9/11 attacks on a 5-point Likert-type scale (1 = *not at all* to 5 = *extremely*). Items from the PCL map onto the 17 *DSM-IV-TR* diagnostic criteria for PTSD. The PCL has been shown to have excellent psychometric properties, with internal consistency ranging from .94–.97 (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996; Weathers et al., 1993). The PCL has also been shown to have very good convergent validity (Weathers et al., 1993). Several published CFAs have demonstrated that the PCL adequately measures constructs/factors of particular interest to the current investigation (e.g., Asmundson et al., 2000; Duhamel et al., 2004; Marshall, 2004; Palmieri & Fitzgerald, 2005).

Although the number of items per symptom cluster and the wordings of the items varied somewhat across the waves of data, the items were largely consistent across waves and tapped the same construct. The PTS reactions indexed by both measures include a diverse array of responses that map onto the 17 symptoms of PTSD, as defined in the *DSM-IV-TR*, which are clustered into three somewhat heterogeneous symptom clusters: Criterion B—reexperiencing of the event, Criterion C—avoidance of reminders of the event and emotional numbing, and Criterion D—hyperarousal. We dismantled each measure into the following conceptually distinct subclusters: reexperiencing (any Criterion B symptoms specified in each measure), strategic avoidance (any symptom that indexed Criterion C1, efforts to avoid thoughts, feelings, and conversations about the trauma, and C2, efforts to avoid activities, places, or people that trigger memories of the trauma), emotional numbing (any symptom that indexed Criterion C4, diminished interest or participation in activities, C5, feelings of detachment from others, and C6, restricted affect), and hyperarousal (any Criterion D symptoms specified in each measure). Items tapping Criterion C3 (difficulties remembering important aspects of the event) and C7 (sense of a foreshortened future) were excluded. We maintain that problems with recall and foreshortened future do not fit conceptually into avoidance or emotional numbing. There is sufficient conceptual and empirical precedent to treat strategic avoidance, as defined by Criteria C1 and C2, and emotional numbing, as defined by Criteria C4, C5, and C6, as separate and distinct subconstructs of PTSD (e.g., Foa, Riggs, & Gershuny, 1995; King, Leskin, King, & Weathers, 1998; Litz et al., 1997).

Procedures

Knowledge Networks Inc. (KN; Menlo Park, CA), a Web-based survey research company that employs the only Internet-based national probability sample in the United States, surveyed participants over time. The distribution of the final sample in the KN panel closely tracks the distribution of U.S. Census counts for a variety of demographic variables. The KN panel is developed using traditional probability methods for creating a national survey sample. To ensure representation of population segments that would not otherwise have Internet access, KN provides panel households with an Internet connection and Web TV appliance. In exchange, panel members agree to complete 3–4 short surveys a month. The panel does not respond significantly differently over time than more naïve survey respondents (Dennis, 2001), and all survey responses are confidential (see Silver et al., 2002, for additional details). Design and procedures were approved by the institutional review boards (IRBs) of UC Irvine and Denver University; the Boston VA Healthcare System IRB approved the analyses conducted.

Data Analysis

A series of CFAs was conducted using the M-plus software program (Muthén & Muthén, 2004). Six competing factor structures were evaluated at each time point (Figure 1): (a) a 1-factor model with all items loading onto a single factor (1-factor model), (b) a 3-factor model that specified three correlated posttraumatic factors: Reexperiencing, Hyperarousal, and a combined Emotional Numbing and Strategic Avoidance factor (3-factor model), (c) a 4-factor model that specified four correlated posttraumatic factors—Reexperiencing, Hyperarousal, and separate Emotional Numbing and Strategic Avoidance factors (4-factor *DSM* Model), (d) a model with 4 first-order factors corresponding to the four symptom clusters with a higher-order PTSD factor accounting for the covariance among the first-order factors (4-factor *DSM* HO model), (e) the 4-factor model proposed by Simms et al. (2002) with reexperiencing, strategic avoidance, hyperarousal, and dysphoria factors (4-factor Simms), and (f) the 4-factor Simms model with a higher-order PTSD factor included. Because the items of the IES-R and PCL were continuous, and item scores were substantially positively skewed, maximum likelihood estimation with the Yuan–Bentler correction for skewness (MLR; Muthén & Muthén, 2004) was used. Maximum likelihood estimation with nonnormal data leads to χ^2 goodness of fit tests that are inaccurate (West, Finch, & Curran, 1995). The MLR estimation corrects standard errors and the χ^2 value when data are skewed. Using MPlus also allowed weighting of data to adjust for differences in the probability of selection and nonresponse (see Silver et al., 2002). Each item was specified to load on a single factor, and covariances among residuals were constrained to zero. Even after removing five cases with excessive missing data, a small number of participants had missing items on one or more of the measures (<3% of the cases at each wave, with the majority missing only one item). Therefore, the expectation maximization algorithm missing data procedure was utilized to make use of partially complete data (McLachlan & Krishnan, 1996). This also enabled the sample to remain consistent across waves.

RESULTS

Table 2 contains descriptive statistics for each item at each wave, and Table 3 reports goodness-of-fit indicators for the CFAs.

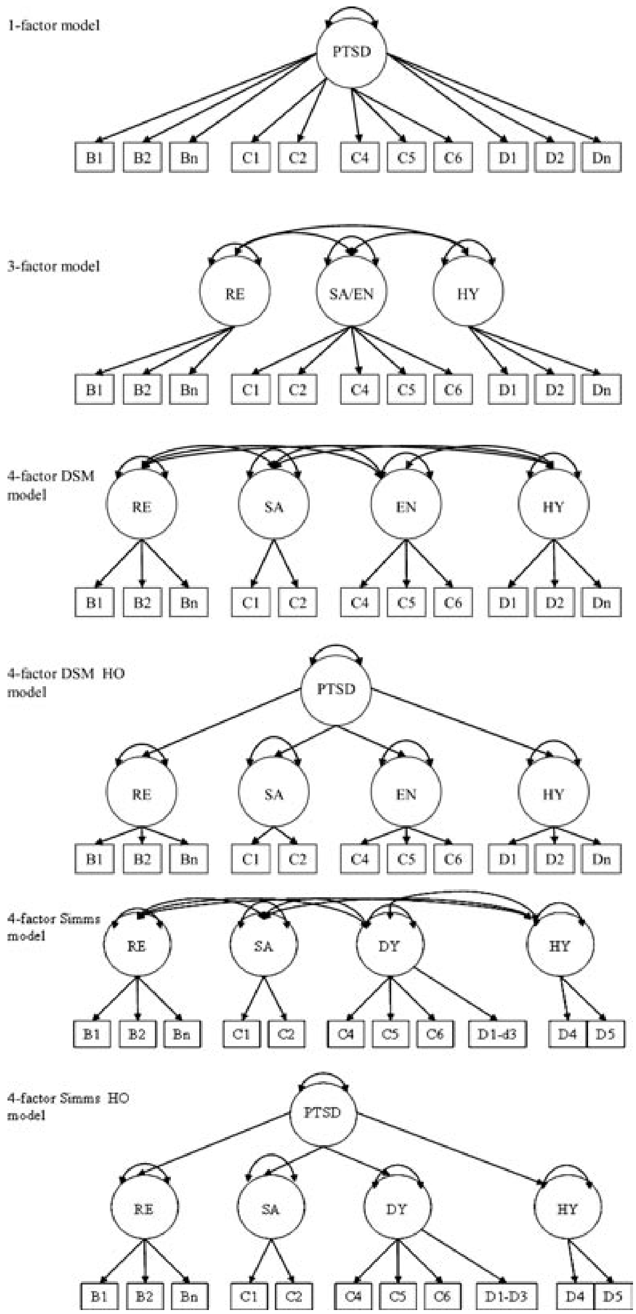

Figure 1. Confirmatory factor analysis models evaluated. EN = emotional numbing, RE = reexperiencing, SA = strategic avoidance, HY = hyperarousal, and DY = dysphoria; HO = higher order; B, C, and D refer to the *DSM-IV-TR* criteria for reexperiencing, avoidance/numbing, and hyperarousal, respectively; subscript n utilized to save space (e.g., so that each of the seven reexperiencing and seven hyperarousal items for the Impact of Events Scale-Revised do not have to be included in each figure).

Overall goodness-of-fit was evaluated using (a) the chi-squared statistic, (b) the comparative fit index (CFI), (c) the Tucker–Lewis Index (TLI), (d) the root mean square error of approximation (RMSEA), (e) and the standardized root mean squared residual (SMSR; see Brown, 2006; Hu & Bentler, 1999 for a review of these indicators). Multiple indicators of goodness-of-fit provide a more conservative and reliable evaluation of various models. The following have been suggested as fit index cutoff values for good models: TLI > .95, CFI > .95, RMSEA < .06, and SRMR < .08 (Hu & Bentler, 1999). Table 3 shows support for the 4-factor *DSM* model at each time point. Although CFI and TLI values did not reach the recommended cutoff values of .95 for the 4-factor higher-order model at Waves 2, 3, and 4, the RMSEA and SRMR values for the 4-factor higher-order solution indicated good model fit. Thus, the 4-factor DSM model fit the data reasonably well (factor loadings presented in Table 2). Because consensus exists that the Bayesian Information Criteria (BIC) is the best indicator for comparing nonnested models and for assessing parsimony, the BIC was used to evaluate competing models directly (i.e., indicator of relative fit). Table 3 shows the 4-factor *DSM* had the lowest BIC values at each wave, suggesting it best fit the data.

That the 4-factor *DSM* model fit the data best at each wave demonstrates a certain level of invariance in the structure across time. Nonetheless, because the IES was administered at Waves 2 and 3, we were able to conduct a longitudinal CFA to further examine the structure of the posttraumatic reactions across this time period (Brown, 2006). Longitudinal CFA procedures were used to assess (a) the equality of factor loadings across time (i.e., factorial invariance), and (b) the equality of factor covariances across time. To assess factorial invariance, we combined the separate CFAs conducted on Waves 2 and 3 into one model. The residuals for each item across time were allowed to covary to provide unbiased estimates of the stability in the factors (Brown, 2006), and each factor was allowed to covary with each other at both waves. After the initial combined (baseline) model was evaluated, the factor loadings for each item were constrained to be equal across the two assessment periods and the model was reevaluated (FL constrained model). The FL constrained model produced a BIC lower than the baseline model (51877 vs. 51914), and a χ^2 difference test indicated that constraining the factor loadings to be equal did not significantly lower model fit, $\Delta\ \chi^2(17) = 14.22$, $p = .65$, suggesting that the indicators evidence equivalent relationships to their respective factors across time. Next, a model with both the factor loadings and covariance among the four factors constrained to be equal was evaluated. This model produced a BIC value higher than the FL constrained model (51,959 vs. 51,877), and a χ^2 difference test indicated that constraining the factor covariances to be equal across time significantly reduced model fit, $\Delta\ \chi^2\ (6) = 25.48$, $p < .001$. This suggests that covariances among factors varied across the two time periods. Examining the correlations among factors across time (see Table 4) reveals that from Waves 2 to 3, correlations between the avoidance cluster and the other

Table 2. Item Descriptive Statistics and Factor Loadings for the 4-Factor DSM-IV Model

	Wave 2					Wave 3 or 4[a]				
Item Number (factor), Item	*M*	Rank	*SD*	Miss	fl	*M*	Rank	*SD*	Miss	fl
IES-R										
1(r) Any reminder brought back feelings about them.	1.07	1	1.08	2	0.76	0.74	1	0.92	3	0.58
3(r) Other things kept making me think about them.	0.89	5	1.06	2	0.78	0.52	3	0.82	4	0.76
6(r) I thought about them when I didn't mean to.	0.80	9	0.95	3	0.81	0.38	11	0.66	2	0.75
9(r) Pictures about them popped into my mind.	0.92	3	1.04	2	0.78	0.46	6	0.76	4	0.78
14(r) I found myself acting or feeling like I was back at that time.	0.33	19	0.74	2	0.68	0.21	19	0.58	2	0.72
16(r) I had waves of strong feelings about them.	0.90	4	1.11	14	0.75	0.43	9	0.78	1	0.80
20(r) I had dreams about them.	0.27	20	0.67	5	0.54	0.15	20	0.48	5	0.67
5(av) I avoided letting myself get upset when I thought about them or was reminded of them.	0.94	2	1.06	7	0.61	0.61	2	0.89	8	0.56
8(av) I stayed away from reminders about them.	0.57	13	0.88	2	0.77	0.35	14	0.66	4	0.71
11(av) I tried not to think about them.	0.88	7	1.02	1	0.80	0.45	7	0.77	1	0.71
17(av) I tried to remove them from my memory.	0.61	12	0.90	4	0.71	0.39	10	0.82	2	0.77
22(av) I tried not to talk about them.	0.55	14	0.94	5	0.72	0.36	12	0.76	2	0.81
12(en) I was aware that I still had a lot of feelings about the attacks, but I didn't deal with them.	0.64	11	0.91	2	0.84	0.36	13	0.72	1	0.87
13(en) My feelings about them were kind of numb.	0.79	10	0.99	1	0.80	0.50	4	0.85	3	0.84
2(hy) I had trouble staying asleep.	0.53	15	0.94	3	0.83	0.28	15	0.71	4	0.83
4(hy) I felt irritable and angry.	0.89	6	1.13	6	0.63	0.44	8	0.80	4	0.65
10(hy) I was jumpy and easily startled.	0.39	18	0.81	3	0.77	0.26	17	0.69	4	0.80
15(hy) I had trouble falling asleep.	0.47	17	0.89	1	0.85	0.27	16	0.69	3	0.87
18(hy) I had trouble concentrating.	0.50	16	0.81	2	0.77	0.25	18	0.60	4	0.88
19(hy) Reminders of them caused me to have physical reactions.	0.21	21	0.59	3	0.66	0.12	21	0.44	3	0.80
21(hy) I felt watchful and on guard.	0.87	8	1.11	5	0.59	0.47	5	0.85	3	0.68
PCL										
1(re) Repeated, disturbing memories, thoughts, or images of the events of September 11						1.61	1	0.86	3	0.72
2(re) Repeated, disturbing dreams of the events of September 11						1.18	15	0.55	2	0.79
3(re) Suddenly acting or feeling as if the events of September 11 were happening again (as if you were reliving them)						1.27	12	0.69	2	0.78
4(re) Feeling very upset when something reminded you of the events of September 11						1.58	2	0.89	4	0.76
5(re) Having physical reactions when something reminded you of the events of September 11						1.19	14	0.58	2	0.75
6(av) Avoiding thinking about or talking about the events of September 11 or avoiding having feelings related to them						1.44	4	0.84	1	0.74
7(av) Avoiding activities or situations because they reminded you of the events of September 11						1.31	8	0.73	4	0.94
9(en) Loss of interest in activities that you used to enjoy						1.31	9	0.73	2	0.94

(Continued)

Table 2. Continued

Item Number (factor), Item	Wave 2 *M*	Rank	*SD*	Miss	fl	Wave 3 or 4[a] *M*	Rank	*SD*	Miss	fl
10(en) Feeling distant or cut off from other people						1.30	10	0.75	2	0.95
11(en) Feeling emotionally numb or being unable to have loving feelings for those close to you						1.21	13	0.59	3	0.74
13(hy) Trouble falling or staying asleep						1.38	5	0.85	2	0.81
14(hy) Feeling irritable or having angry outbursts						1.32	7	0.76	0	0.85
15(hy) Having difficulty concentrating						1.36	6	0.84	1	0.85
16(hy) Being 'superalert' or watchful or on guard						1.51	3	0.89	1	0.75
17(hy) Feeling jumpy or easily startled						1.30	11	0.72	2	0.83

Notes. *M* = mean; Rank = rank order of item in terms of average response; *SD* = standard deviation; Miss = number of missing cases for that item (descriptive statistics are based on the parameters produced by the expectation maximation of missing data procedure parameters, so the *N* is 675 for all items at all waves); fl = the completely standardized factor loading for each item for the 4-factor lower order solution; IES-Revised = Impact of Event Scale-Revised; PCL = PTSD Checklist; re = rexperiencing; av = avoidance; en = emotional numbing; hy = hyperarousal.
[a] IES-R administered at Wave 3; PCL administered at Wave 4.
The IES-R items were completed with respect to "the attacks of September 11."

Table 3. Goodness of Fit Indicators for the CFA Analyses ($N = 675$)

Model	χ^2 (MLR)	*df*	CFI	TLI	RMSEA	SRMR	BIC
Wave 2 IES-R							
1-Factor	915.72	189	0.79	0.77	0.075	0.072	31176.03
3-Factor	593.91	186	0.88	0.87	0.057	0.059	30367.18
4-Factor *DSM**	551.41	183	0.89	0.88	0.055	0.055	30276.55
4-Factor Simms	683.72	183	0.85	0.83	0.064	0.062	30608.19
4-Factor *DSM*, 1 higher order	610.47	185	0.88	0.86	0.058	0.064	30416.60
4-Factor Simms, 1 higher order	681.11	185	0.86	0.84	0.063	0.063	30602.69
Wave 3 IES-R							
1-Factor	951.59	189	0.74	0.72	0.077	0.077	23093.55
3-Factor	734.50	186	0.82	0.79	0.066	0.073	22586.29
4-Factor *DSM**	664.29	183	0.84	0.82	0.062	0.070	22384.48
4-Factor Simms	826.37	183	0.79	0.75	0.072	0.074	22714.20
4-Factor *DSM*, 1 higher order	665.08	185	0.84	0.82	0.062	0.071	22401.93
4-Factor Simms, 1 higher order	823.68	185	0.79	0.76	0.072	0.074	22709.69
Wave 4 PCL							
1-Factor	1785.00	90	0.74	0.69	0.086	0.074	16817.22
3-Factor	485.61	87	0.76	0.71	0.082	0.092	16317.25
4-Factor *DSM**	313.23	84	0.86	0.83	0.064	0.057	15815.80
4-Factor Simms	344.51	84	0.85	0.81	0.068	0.057	16023.51
4-Factor *DSM*, 1 higher order	337.60	86	0.85	0.82	0.062	0.066	15862.04
4-Factor Simms, 1 higher order	359.42	86	0.84	0.80	0.069	0.061	16049.25

Note. MLR indicates that Yuan–Bentler Chi-Squared (corrected for skewness) are being presented. df = Degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean squared residual; IES-R = Impact of Events Scale Revised; PCL = Posttraumatic Disorder Checklist.
*signifies the best-fitting model.

Table 4. Correlations Among the 4-Factors of the 4-Factor *DSM* Model at Each Assessment Point and Differences in the Correlation Coefficients Across Assessment Points

		W2				W3				W4			
		RE	AV	EN	HY	RE	AV	EN	HY	RE	AV	EN	HY
W2	RE												
	AV	.90											
	EN	.84	.90										
	HY	.88	.64	.78									
W3	RE												
	AV	(−.11)				.79							
	EN	(.02)	(−.14)			.86	.76						
	HY	(.00)	(.13)	(−.06)		.88	.77	.72					
W4	RE												
	AV	(−.13)				(−.02)				0.77			
	EN	(−.10)	(−.34)			(−.12)	(−.20)			0.74	0.56		
	HY	(−.07)	(.03)	(.02)		(−.07)	(−.10)	(.08)		0.81	0.67	0.80	

Note. RE = Reexperiencing; AV = avoidance; EN = emotional numbing; HY = hyperarousal; W = wave. Correlations within each wave depicted in the diagonal cells without parenthesis.
Difference between correlation coefficients across waves depicted in off-diagonal cells (within parentheses).
All correlations within each wave were statistically significant at $p < .001$ at each time point.

clusters changed in different directions, and the biggest change from Waves 2 to 4 was in the correlation between avoidance and numbing.

DISCUSSION

There is debate about whether PTSD is the framework that best captures the symptoms reported by those who were indirectly exposed on 9/11 (e.g., Maguen & Litz, 2006; Sabin-Farrell & Turpin, 2003). We found that the stress symptoms of individuals indirectly exposed to the attacks of 9/11 clustered in the way that would be expected of symptoms reported by direct survivors, replicating a 4-factor, lower-order PTSD structure, consistent across three time points. Our study supported a slightly different 4-factor model than the one identified by Baschnagel et al. (2005; labeled Simms above). In addition, there was no support for a higher-order factor that accounted for the covariance among subclusters, which was not tested by Baschnagel and colleagues. However, the convergence of the findings is noteworthy. In both studies, 4-factor structures emerged as the best-fitting model, and both of these models have been identified as the best-fitting models among those directly exposed to trauma (e.g., King, Leskin, King, & Weathers, 1998; Simms et al., 2002). Thus, the number and nature of factors underlying PTS reactions to indirect exposure to trauma mirror those that underlie direct exposure. Because of methodological differences between this study and Baschnagel et al. (2005), future research should explore the best-fitting model.

Although a 4-factor, lower-order solution emerged across all waves, the goodness of fit indicators for these models were mixed, with RMSEA and SRMR values indicating adequate to good fit, and CFI and TFI values indicating less than adequate fit. Other CFA studies have reported less than ideal goodness of fit indicators for best-fitting PTSD models (e.g., McWilliams, Cox, & Asmundson, 2005). This may indicate problems with the current criteria. In particular, *DSM-IV-TR* Criterion C might warrant revision. The *DSM-IV-TR* only includes two items tapping strategic avoidance, which is problematic given that factors with less than five items are often not considered in factor analytic studies because of concerns about stability and validity (Asmundson et al., 2004). The emotional numbing construct remains poorly operationalized (Litz & Gray, 2002). For the current analyses, we excluded items related to amnesia about the event and a sense of a foreshortened future on conceptual and empirical grounds. Because these items have produced the weakest factor loadings in previous factor analytic studies (e.g., Baschnagel et al., 2005; King et al., 1998; Palmieri & Fitzgerald, 2005), their exclusion likely had little effect on the results.

Despite the fact that the symptom clusters conformed to a structure that is consistent with the PTSD construct, most individuals reported minimal levels of distress, and as a result, did not approach meeting criteria for a clinical disorder (see Silver et al., 2002). Therefore, it is unlikely that these low-level symptoms had an impact on functioning. However, examining reactions to a wide variety of potentially traumatic stressors has important theoretical and practical value, contributing to the debate as to whether or not PTSD is an entity that is distinct from normal stress reactions. Two recent studies utilizing taxometric procedures concluded that the PTSD construct captures a continuum of postevent adaptation, ranging from mild stress to severe and incapacitating disorder and dysfunction, rather than a discrete clinical syndrome (Forbes, Haslam, Williams, & Creamer, 2005; Ruscio, Ruscio, & Keane, 2002). On the other hand, Breslau, Reboussin, Anthony, and Storr, (2005) interpreted the results of two latent class analyses as supporting the existence of three ordinal, but discrete, classes representing no disturbance, intermediate disturbance, and pervasive disturbance. These classes not only differed in terms of severity of response, but also in the types of symptoms defining the class, with emotional numbing symptoms more prominent in the pervasive class than in the other two. The results of the current study are more in line with the position that PTSD is best viewed as a continuum. However, future research that directly compares reactions of those directly and indirectly exposed to a traumatic event is needed to clarify this issue further.

Our findings supported partial measurement invariance (i.e., consistency in the factor structure) across time (Brown, 2006). However, the relationships among the four clusters changed over time. This is consistent with the four symptom clusters representing related, but distinct types of reactions, and that there are differential relationships among PTSD symptom clusters across time (e.g., Schnell, Marshall, & Jaycox, 2004). More longitudinal research is needed to explicate the consequences of differential relationships among the symptom clusters across time.

It is important to acknowledge several limitations. First, only a subsample of individuals, among a larger group studied over time, completed all waves. Nonetheless, attrition analyses suggest that the dropout was essentially random and the resulting sample was representative of the U.S. adult population. Second, different measures of PTS symptoms were utilized across waves. Despite this limitation, the factor structure of the symptom clusters across time is noteworthy. Finally, we lacked sufficient data to test the criterion validity of the factor solution.

Individuals in this national study who were indirectly exposed to 9/11 reported minimal and low-magnitude symptoms that followed a pattern consistent with current conceptualizations of the PTSD construct. We demonstrate that PTS symptoms following indirect trauma exposure conform to a 4-factor lower-order model of PTSD, consistent with previous studies on the factor structure of PTSD (Asmundson et al., 2004; King et al., 2006).

REFERENCES

Ahern, J., Galea, S., Resnick, H., & Vlahov, D. (2004). Television images and probable posttraumatic stress disorder after September 11: The role of background characteristics, event exposures, and perievent panic. Journal of Nervous and Mental Disease, 192, 217–226.

American Psychiatric Association. (2000). Diagnostic and statistical manual of mental disorders (4th ed., text rev.). Washington, DC: Author.

Asmundson, G. J., Frombach, I., McQuaid, J., Pedrelli, P., Lenox, R., & Stein, M.B. (2000). Dimensionality of posttraumatic stress symptoms: A confirmatory factor analysis of DSM-IV symptom clusters and other symptom models. Behavior Research and Therapy, 38, 203–214.

Asmundson, G. J. G., Stapleton, J. A., & Taylor, S. (2004). Are avoidance and numbing distinct PTSD symptom clusters? Journal of Traumatic Stress, 17, 467–475.

Baschnagel, J. S., O'Connor, R. M., Colder, C. R., & Hawk, L. W. (2005). Factor structure of posttraumatic stress among Western New York undergraduates following the September 11th terrorist attack on the World Trade Center. Journal of Traumatic Stress, 18, 677–684.

Blanchard, E. B., Jones-Alexander, J., Buckley, T. C., & Forneris, C. A. (1996). Psychometric properties of the PTSD Checklist (PCL). Behaviour Research and Therapy, 34, 669–673.

Breslau, N., Reboussin, B. A., Anthony, J. C., & Storr, C. L. (2005). The structure of posttraumatic stress disorder: Latent class analysis in 2 community samples. Archives of General Psychiatry, 62, 1343–1351.

Brown, T. A. (2006). Confirmatory factor analysis for applied research. New York: Guilford Press.

Creamer, M., Bell, R., & Failla, S. (2003). Psychometric properties of the Impact of Event Scale- Revised. Behaviour Research and Therapy, 41, 1489–1496.

Dennis, J. M. (2001, Summer). Are Internet panels creating professional respondents? The benefits of online panels far outweigh the potential for panel effects. Marketing Research, 13, 34–38.

Duhamel, K. N., Ostroff, J., Ashman, T., Winkel, G., Mundy, E. A., Keane, T. M., et al. (2004). Construct validity of the Posttraumatic Stress Disorder Checklist in cancer survivors: Analyses based on two samples. Psychological Assessment, 16, 255–266.

Foa, E. B., Riggs, D. S., & Gerhsuny, B. S. (1995). Arousal, numbing, and intrusion: Symptom structure of PTSD following assault. American Journal of Psychiatry, 152, 116–120.

Forbes, D., Haslam, N., Williams, B. J., & Creamer, M. (2005). Testing the latent structure of posttraumatic stress disorder: A taxometric study of combat veterans. Journal of Traumatic Stress, 18, 647–656.

Horowitz, M. J., Wilner, N., & Alvarez, W. (1979). Impact of Events Scale: A measure of subjective distress. Psychosomatic Medicine, 41, 209–218.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling, 6, 1–55.

King, L. A., King, D. W., Orazem, R. J., & Palmieri, P. A. (2006). Research on the latent structure of PTSD. PTSD Research Quarterly, 17, 1–7.

King, D. W., Leskin, G. A., King, L. A., & Weathers, F. W. (1998). Confirmatory factor analysis of the Clinician-Administered PTSD Scale: Evidence for the dimensionality of posttraumatic stress disorder. Psychological Assessment, 10, 90–96.

Litz, B. T., & Gray, M. (2002). Emotional numbing in posttraumatic stress disorder: Current and future research directions. Australian and New Zealand Journal of Psychiatry, 36, 198–204.

Litz, B. T., Schlenger, W. E., Weathers, F. W., Caddell, J. M., Faibank, J. A., & LaVange, L. M. (1997). Predictors of emotional numbing in posttraumatic stress disorder. Journal of Traumatic Stress, 10, 607–618.

Maguen, S., & Litz, B. T. (2006). Coping with the threat of terrorism: A working model. In Y. Neria, R. Gross, R. Marshall, & E. Susser (Eds.), 9/11: Mental health in the wake of terrorist attacks (pp. 570–591). New York: Cambridge University Press.

Marshall, G. N. (2004). Posttraumatic Stress Disorder Checklist: Factor structure and English–Spanish measurement invariance. Journal of Traumatic Stress, 17, 223–230.

McLachlan, G. J., & Krishnan, T. (1996). The EM algorithm and extensions. New York: Wiley Interscience.

McWilliams, L. A., Cox, B. J., & Asmundson, G. J. G. (2005). Symptom structure of posttraumatic stress disorder in a nationally representative sample. Journal of Anxiety Disorders, 19, 626–641.

Muthén, L. K., & Muthén, B. O. (2004). Mplus User's Guide. Los Angeles, CA: Author.

Palmieri, P. A., & Fitzgerald, L. F. (2005). Confirmatory factor analysis of posttraumatic stress symptoms in sexually harassed women. Journal of Traumatic Stress, 18, 657–666.

Pollock, M. H., Simon, N. M., Fagiolini, A., Pitman, R., McNally, R. J., Nierenberg, A. A., et al. (2006). Persistent posttraumatic stress disorder following September 11 in patients with bipolar disorder. Journal of Clinical Psychiatry, 67, 394–399.

Ruscio, A. M., Ruscio, J., & Keane, T. M. (2002). The latent structure of posttraumatic stress disorder: A taxometric investigation of reactions to extreme stress. Journal of Abnormal Psychology, 111, 290–301.

Sabin-Farrell, R., & Turpin, G. (2003). Vicarious traumatization: Implications for the mental health of health workers? Clinical Psychology Review, 23, 449–480.

Schlenger, W. E., Caddell, J. M., Ebert, L., Jordan, B. K., Rourke, K. M., Wilson, D., et al. (2002). Psychological reactions to terrorist attacks: Findings from the National Study of Americans' Reactions to September 11. JAMA, 288, 581–588.

Schnell, T. L., Marshall, G. N., & Jaycox, L. H. (2004). All symptoms are not created equal: The prominent role of hyperarousal in the natural course of posttraumatic psychological distress. Journal of Abnormal Psychology, 113, 189–197.

Silver, R. C., Holman, E. A., McIntosh, D. N., Poulin, M., & Gil-Rivas, V. (2002). Nationwide longitudinal study of psychological responses to September 11. JAMA, 288, 1235–1244.

Silver, R. C., Holman, E. A., McIntosh, D. N., Poulin, M., Gil-Rivas, V., & Pizarro, J. (2006). Coping with a national trauma: A nationwide longitudinal study of responses to the terrorists attacks of September 11th. In Y. Neria, R. Gross, R. Marshall, & E. Susser (Eds.), 9/11: Mental health in the wake of terrorist attacks (pp. 45–70). NY: Cambridge University Press.

Silver, R. C., Poulin, M., Holman, E. A., McIntosh, D. N., Gil-Rivas, V., & Pizarro, J. (2005). Exploring the myths of coping with a national trauma: A longitudinal study of responses to the September 11th terrorist attacks. Journal of Aggression, Maltreatment & Trauma, 9, 129–141.

Simms, L. J., Watson, D., & Doebbelling, B. N. (2002). Confirmatory factor analyses of posttraumatic stress symptoms in deployed and nondeployed veterans of the Gulf War. Journal of Abnormal Psychology, 111, 637–647.

StataCorp. (2003). Stata statistical software (Version 8.0) [Computer software]. College Station, TX: Author.

Tucker, P., Pfefferbaum, B., Nixon, S., & Dickson, W. (2000). Predictors of posttraumatic stress symptoms in Oklahoma City: Exposure, social support, peritraumatic responses. Journal of Behavioral Health Services & Research, 27, 406–416.

U.S. Census Bureau. (2001). Current population survey. Retrieved September 11, 2001, from http://www.census.gov

Weathers, F. W., Litz, B. T., Herman, D. S., Huska, J. A., & Keane, T. M. (1993, October). The PTSD Checklist (PCL): Reliability, validity, and diagnostic utility. Paper presented at the annual meeting of the International Society for Traumatic Stress Studies, San Antonio, TX.

Weiss, D. S., & Marmar, C. R. (1997). The Impact of Event Scale-Revised. In J. P. Wilson & T. M. Keane (Eds.), Assessing psychological trauma and PTSD (pp. 399–411). New York: Guilford Press.

West, S. G., Finch, J. F., & Curran, P. J. (1995). Structural equation models with nonnormal variables: Problems and remedies. In R. H. Hoyle (Ed.), Structural equation modeling: Concepts, issues, and applications. Thousand Oaks, CA: Sage.

Zimering, R., Gulliver, S. B., Knight, J., Munroe, J., & Keane, T. M. (2006). Posttraumatic stress disorder in disaster relief workers following direct and indirect trauma exposure to Ground Zero. Journal of Traumatic Stress, 19, 553–557.